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Disability-Free Life Expectancy in Urban and Rural Areas of India using Sullivan Technique

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Abstract: The present research work is relating to health status based on Disability-Free Life Expectancy (DFLE) between urban and rural areas in India. Framework of rapid urbanization in India has been set over past few decades. This brings strong decline in the quality of life due to population ageing and ensuring sustainability of health care systems and reduction of disability among elderly Indian population. This paper also explores on disability prevalence and the potential link between poverty and disability. This paper will observe a direct relationship between the poverty rate and disability prevalence in India. Aim of the present research work is for estimating DFLE of Indians of all ages in urban and rural areas and to examine whether differences in DFLE exists between above two areas. Data from SRS and Indian Census 2011 are utilized under present work. Technique of Sullivan is applied for the estimation of DFLE in India. Rural areas exhibit higher rates of age-specific mortality than that of its urban counterpart. Higher rates of age-specific disability in rural areas, which is statistically insignificant here, were observed as compared to urban areas. Above two observations reveal about significant differences in disability prevalence and mortality occurrence from birth to age 80^{+}between urban and rural areas of India. Urban population has longer life expectancies and also DFLE than that of rural population from birth to age 80^{+}. Present study exhibits about presence of inequalities in life expectancies, DFLE and life expectancies with disabilities between urban and rural areas in India together with their age-specific differences as well. These findings may be useful and yardstick for implications of various policies in way to reduce the inequalities in health-related outcomes.

Keywords: Disability and Poverty; Disability-Free Life Expectancy; Life Table Technique; Sullivan Technique.

I. INTRODUCTION

Life Expectancy (LE) is an estimate of how many years a person might be expected to survive at age x (x may be any time period including date of birth) while healthy life expectancy is an estimate of how many years a person might be remained in healthy state of life. Sanders (1964) presented first time the concept of health indicator combining information related to mortality and morbidity. Sullivan (1971) developed a technique to estimate the Disability-Free Life Expectancy (DFLE). Health expectancy indices combine mortality and morbidity into a single composite indicator, which is very attractive device to monitor long-term trend for the evolution of population health in way to address expansion of morbidity in population. Sullivan technique utilizes information related to prevalence of health states in Indian population.

The observed age-specific prevalence of health states in a population in a given geographical area and at a given point of time is utilized in the Sullivan technique. The years of life survived in the various health states at each age are computed using a period life table cohort. Mathers and Robine (1997) discussed problems relating to the validity of the Sullivan method first time raised by Bebbington, Brouard and Robine in 1989. Bebbington compared the Sullivan technique with the double decrement life table method using data where the disability incidence rate was rising over time. He then demonstrated that the Sullivan method provides a lower estimate of disability than the double decrement method due to reflecting the past experience of each cohort ignoring the current incidence rate in the disability prevalence. Brouard and Robine (1992) argued in similar manner while incidence of disability is a flow to compute a pure period proportion of disabled people, not depending on the past flows. This could be used to compute pure period indicator of DFLE. Rogers, Rogers and Belanger (1990) advocated that the Sullivan method generates biased estimate of active life expectancy in the direction of increased dependency.

II. DEVELOPMENT OF DISABILITY

Only few censuses, surveys and registration sources of information on disability are available for quantifying the disability with conceptual and definitional problems abound. Numerous efforts were made to quantify the disability on the globe, what are the main reasons of disability and how many disabilities exist in different regions affecting the quality of life of people on the globe?

As per historical viewpoint, disability was canvassed during 1872 to 1931 and this was not canvassed during 1941 to 1971 in India due to lack of reliable data. Year 1981 is declared as the International year of disabled persons. That is why; data on three types of disability was collected during 1981 census (Census of India, 1981). As per Commissioner of 1981 census,

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the census operations do not lend themselves to the identification of people with disability hence, the question on disability, thus, was again dropped during 1991 census. Collection of disability data was again included during 2001 census with 5 types of disabilities and in 2011 censuses with 8 types of disabilities in India (Census of India, 2001 and 2011).

WHO (2002) reported that disabled persons are not only the most deprived human beings in the society but also they are the most neglected? A separate Department of Disability Affairs was created under the Ministry of Social Justice and Empowerment to look after activities for the welfare and empowerment of persons with disability on 12th May 2012. Latter in 2014, this Department was renamed as Department of Empowerment of Persons with Disabilities (Divyangjan). This Department acts as Nodal Agency for matters pertaining to disability and persons with disabilities along with closer coordination among different stakeholders. Paul and Saha (2015) concluded that prevalence of disability among females, in general, is lower than that of male counterpart for all types of disabilities during 1881 to 2011 in India. They further mentioned that over 26 million disabled persons is not a healthy indicator. This needs for detailed investigation on demographical disability.

The Right of Persons with Disabilities Bill - 2016 passed by Indian Parliament in December 2016 with following salient features: **(i)** Disability will be defined based on an evolving and dynamic concept **(ii)** The types of disabilities have been increased from existing 8 to 21 types and Central Government has power to add more types of disabilities, if any **(iii)** Responsibility has been given to the appropriate Governments for effective measures to be taken to ensure the disabled-person enjoy their right equally with others **(iv)** Reservation (increased from 3% to 4%) in Higher Education, Government Jobs, reservation in allocation of land, poverty alleviation schemes etcetera have been provided for them as an additional benefit (**v**) Every disabled child between ages 6 to 18 years shall have the right to free education (**vi**) Government recognized institutions and Government funded institutions will have to provide inclusive education to the disabled-children (**vii**) The Chief commissioner for Persons with Disabilities and the State Commissioners will act as regulatory bodies and Grievance Redressal agencies will monitor implementation of the Act by creating National and State Fund and penalties for offences committed against disabled-persons.

III. PREVALENCE OF DISABILITY IN RURAL AND URBAN INDIA

The prevalence of disability, in general, is probable to be higher in urban areas than that of its rural counterpart because greater risk of injury from accidents, the pull factor of services, institutions, the existence of sedentary jobs and others. The UN recapitulates that higher disability rates tend to be found among rural inhabitants with a ratio of rural/urban disability usually less than 2. Census 2001 has revealed that over 21 million persons (12.6 million males and 9.3 million females) are suffering from disability, which is an equivalent to 2.10 % of total population. But an increased trend has been emerged during 2011 census. Over 26.8 million persons (15 million males and 11.8 million females) are suffering from disability, which is an equivalent to 2.21 % of total population. Rural areas (2.23%) provide more disabled persons than that of urban areas (2.16%). 2011 census illustrates that 69.50 percent of persons with disabilities live in rural areas. Census 2011 provides the most recent data on disability giving a picture of disability prevalence including its nature throughout the whole India.

There is a massive difference between rise in absolute numbers in rural and urban areas. Uttar Pradesh has the highest number of disabled persons among all states. Disability among Scheduled Tribes in lower age-groups up to 40-49 ages is significantly lower than the other social groups while higher disability was found among Scheduled Tribes persons with age group 60 onwards.

Islam et al. (2017) demonstrated that inequalities between urban and rural areas of Bangladesh among LE, DFLE and LE with disability were observed along with the age-specific differences as well. These findings have important implications to reduce rural-urban inequalities in health-related outcomes and will be useful and yardstick for the intervention of policy in reducing the gap among health outcomes.

IV. NEXUS BETWEEN POVERTY AND DISABILITY

Singh (2012) discussed that poverty arises when people are deprived of income and other resources required getting the conditions of life — diets, facilities, material goods, standard and services — that enable them in playing roles to meet the obligations and participate in the relationship and customs of their society. Poverty is now widely considered to be a multidimensional problem. The concept of poverty reflects failure in many dimensions of human life – unemployment, hunger, illness and health care, homelessness, powerlessness and victimization and social injustice. All of them add up to an assault of human dignity. The eight Indian states, viz., Bihar, Jharkhand, Madhya Pradesh, Utter Pradesh, Chhattisgarh, Odisha, Rajasthan and West Bengal have maximum number of poor persons. As per 2015 global multidimensional poverty index, Kerala, Tamil Nadu, Himachal Pradesh, Punjab, Mizoram, Goa and Delhi continued as the least poor Indian states. Singh (2011) summarized that interrelation between poverty and human development is negative and they are mutually exclusive. Equal attention is required to give on each of three pillars of development such as social, economic and environment for better livelihood and improvement of human and gender-related development indices.

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Interdependent relationship between poverty and disability persists as a neglected area of research. The research findings across the world have pointed out that the poorest and most marginalized section in the country is represented by disabled persons and the disability endures an extremely important risk of falling under poverty among the working-age inhabitants. The issue of poverty remains a significant characteristic for persons with disabilities, whereby disability is maintained by both, a cause and consequences of poverty. Groce et al. (2011) discussed that idea of disability by both, a cause and consequences of poverty was investigated the economic wellbeing of families with disabled members and they considered disability is a cause-based because those persons have lower education and work opportunities than the rest of the population and are therefore more likely to remain below the poverty line. As per UN (2011) forecast, population of over age 60 years old will be 323 million in India by 2050. The aging is closely related with increasing prevalence of disability leaving important structural and financial challenges related to absolute number of disabled persons requiring adequate social and health care. Filmer (2008) further discussed that absolute increases in number of disabled persons also produce challenges for sustainable development in India because disability among developing countries like India is closely related to the lack of education, extreme poverty and social exclusion. Thus, all of these important issues require the careful monitoring and planning of financial resources.

Disability is a relative term and its measurement is beset with occurring of problems with deficiency of reliability and validity and most of which are poorly standardized and also produce non-comparable estimates. Usually, disabled persons have lower education and also lower income levels than that of the rest population. They are more likely to have their income below poverty line (BPL), less savings and other assets than that of the non-disabled persons. The disabled persons still face a higher risk of falling into the poverty. Thus, poverty and disability look to be inextricably linked. WHO recently define new version of international classification of functioning and disability (the Beta - 2 version of ICIDH - 2) for testing and comment. The aim of the ICIDH - 2 classification is to provide a unified and standard language and framework for the description of human functioning and disability as an important component of health (WHO, 2001). The classification organizes information according to three dimensions: body level, individual level and society level and incorporates a list of environmental factors, since they have an impact on all three dimensions mentioned above (WHO, 1980).

V. USE OF SULLIVAN METHOD IN LIFE EXPECTANCY OF DISABLE PERSONS

The Sullivan health expectancy reflects the current health of a population adjusted for levels of mortality and independent of age structure. A person of particular age, who is expected to survive many years in a healthy state, is called Sullivan health expectancy. Data on age-specific prevalence (in proportion) of the population in both, healthy and unhealthy states and age-specific mortality information from a period life table are required to compute Sullivan health expectancy. The Sullivan health expectancy is not very sensitive to the size of age-group and it is preferably to use five-year age intervals since most of the surveys on healthy and unhealthy states are conducted in five-year interval. It gives a method for comparing health states of an entire population at two different points of time or two different populations at the same point of time irrespective of differences in age composition provided the age intervals are not of too large. Following two assumptions need to be made for the comparison among numerous health expectancies: (i) The same definitions should be employed for each of the health expectancies. (ii) The general and same frameworks of surveys should be utilized to derive the prevalence.

Longer people survive and as they become older, the more health becomes a dominant issue. Along with it, an aging population approaches alarming health problems like chronic disease (i. e. cardiovascular disease) and disability. The focus relates to chronic disease specifically cardiovascular disease, as they cause much human suffering, create substantial threats to economies of individual counties and contribute to health inequalities of countries and within population worldwide (WHO, 2002). The term morbidity refers to a manifestation of ill health. The comparison of morbidity hypothesis assumes that the length of life is fixed and chronic disease and related disability can be postponed to older ages (Fries, 1980). The opposite hypothesis related to expansion of morbidity and states of reduction will produce more years with morbidity and related disability.

Mortality is a fundamental factor in population dynamics. The overall mortality rate of human being has declined drastically throughout the world during the last half centuries. Life expectancy at birth has increased greatly, infant and child mortality has declined significantly and mortality has shifted to older ages. The survival of the old aged population has increases substantially since 1950.

VI. METHODOLOGY

Disability-free life expectancy (DFLE) is an indicator that combines information on mortality and morbidity (Sullivan, 1971). There are several possible computation methods of DFLE and Sullivan method is one of them. Sullivan health expectancy reflects the current health of real population adjusted for mortality levels and independent of age structure. The Sullivan health expectancy provides a means of comparing health states of an entire population at two time points or two different populations at the same point despite any differences in age composition. DFLE based on Sullivan's method discussed by Imai and Soneji (2007) exercises the mortality data from a period LT and the disability prevalence data from

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a cross-sectional survey. They further added that theoretical definition of life expectancy is provided within the continuous-time framework, the data are typically recorded in a discrete form. Sullivan's method also requires the use of a period LT. Unlike life expectancy, DFLE cannot be estimated from a period LT alone without additional information about disability prevalence, i.e., DFLE is measured by combining mortality information from a period LT and disability information from a cross-sectional disability survey.

LT functions are defined as:

Let l_x = No. of persons surviving to exact age x

L_x = Total No. of years lived in the age interval (x, x+5)

π_x = Observed prevalence of disability in the age interval (x, x+5)

$DFLE_x$ = Disability-Free Life Expectancy at age x

DLE_x = Life Expectancy with Disability at age x

Two states are called disability-free and with disability. Then Sullivan methods based on $DFLE_x$ and DLE_x are defined by following formulae (Jagger, Oyen and Robin, 2014):

$$DFLE_x = \frac{\sum_{i=x}^{w} L_i\,(DF)}{l_x} \qquad (1)$$

$$DLE_x = \frac{\sum_{i=x}^{w} L_i\,(D)}{l_x} \qquad (2)$$

where $L_i(DF)$ and $L_i(D)$ are the number of persons lived from age x onwards in the state of disability-free and with disability up to w, the last age interval respectively.

Formulae (1) and (2) will be applied to compute life expectancies for rural and urban areas only and hence, both life expectancies will be compared. There are numerous variants available to compute life tables (Complete or Abridged). Complete LT is computed from annual data, while Abridged LT is computed for age groups of five or ten yearly. The data for present study includes registered mortality rates were collected from Sample Registration System, Office of the Registrar General of India and disability with population from Table C-14 and Table C-20, Census of India, 2011. Disability prevalence at single year ages is estimated from disability prevalence in five year age groups fitting the regression model. DFLE is originated by partitioning the person years survived to that age with and without disability. Ten year age groups are counted for Abridged LT apart from the final open-ended group of 80^+ years. Mortality across the first year of age is not as uniform as across other age intervals. The first ten-year age group only is split into 5-year age groups, 0-4 and 5-9.

VII. CALCULATION OF DFLE

Table 1: Calculation of Disability-Free Expectancy (DFLE) by the Sullivan Method using Abridged Life Table for Urban Population

Age Interval	Conditional probability of death	Number surviving to age x	Person years lived at age x	Total number of years lived from age x	Total life expectancy	Proportion with disability	Person years lived without disability in age interval	Total years lived without disability from age X	Disability free life expectancy	Prop. of life spent disability free
X	q_x	l_x	${}_nL_x$	T_x	e_x	π_x	$[1-\pi_x]$ L_x	$\sum[1-\pi_x]L_x$	$DFLE_x$	% $DFLE_x / e_x$
0-4	0.00737	100000	398525	8225432	82.25	0.0129	393397	8002029	80.02	97.28
5-9	0.00050	99263	496190	7826907	78.85	0.0162	488145	7608632	76.65	97.21
10-19	0.00080	99213	991732	7330717	73.89	0.0186	973249	7120487	71.77	97.13
20-29	0.00134	99133	990667	6338985	63.94	0.0199	970920	6147238	62.01	96.98
30-39	0.00184	99000	989088	5348317	54.02	0.0211	968268	5176318	52.29	96.78
40-49	0.00404	98818	986181	4359229	44.11	0.0228	963712	4208050	42.58	96.53
50-59	0.00899	98419	979765	3373049	34.27	0.0266	953711	3244338	32.96	96.18

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60-69	0.01965	97534	965758	2393284	24.54	0.0353	931664	2290627	23.49	95.71
70-79	0.00704	95617	952806	1427526	14.93	0.0480	907117	1358963	14.21	95.20
80^{+}	0.09442	94944	474720	474720	5.00	0.0482	451846	451846	4.76	95.18

Table 2: Calculation of Disability-Free Expectancy (DFLE) by the Sullivan Method using Abridged LIFE Table for Rural Population

Age Interval	Conditional probability of death	Numbers surviving to age x	Person years lived at age x	Total number of years lived from age x	Total life expectancy	Proportion with disability	Person years lived without disability in age interval	Total years lived without disability from age X	Disability free life expectancy	Prop. of life spent disability free
X	q_x	l_x	${}_nL_x$	T_x	e_x	π_x	$[1-\pi_x]L_x$	$\sum[1-\pi_x]L_x$	$DFLE_x$	$\%\ DFLE_x / e_x$
0-4	0.01351	100000	397298	8092099	80.92	0.0109	392953	7836538	78.37	96.84
5-9	0.00110	98649	492975	7694800	78.00	0.0151	485520	7443585	75.46	96.74
10-19	0.00108	98541	984876	7201825	73.08	0.0181	967085	6958065	70.61	96.62
20-29	0.00185	98435	983437	6216949	63.16	0.0196	964204	5990979	60.86	96.37
30-39	0.00274	98253	981181	5233512	53.27	0.0209	960712	5026775	51.16	96.05
40-49	0.00488	97983	977444	4252331	43.40	0.0233	954671	4066064	41.50	95.62
50-59	0.01047	97505	969951	3274888	33.59	0.0291	941701	3111393	31.91	95.01
60-69	0.02718	96485	951738	2304937	23.89	0.0440	909842	2169691	22.49	94.13
70-79	0.05832	93863	911256	1353199	14.42	0.0680	849257	1259850	13.42	93.10
80^{+}	0.10157	88389	441943	441943	5.00	0.0709	410593	410593	4.65	92.91

Table 3: Comparison of Life Expectancy and Disability Free Life Expectancy in Urban and Rural Population

Age Interval	Life expectancy		Difference in LE (Urban-Rural)	DFLE		Difference in (Urban-Rural)
	Urban	Rural		Urban	Rural	
0-4	82.25	80.92	1.33	80.02	78.37	1.65
5-9	78.85	78.00	0.85	76.65	75.46	1.19
10-19	73.89	73.08	0.81	71.77	70.61	1.16
20-29	63.94	63.16	0.78	62.01	60.86	1.15
30-39	54.02	53.27	0.75	52.29	51.16	1.13
40-49	44.11	43.40	0.71	42.58	41.50	1.08
50-59	34.27	33.59	0.68	32.96	31.91	1.05
60-69	24.54	23.89	0.65	23.49	22.49	1.00
70-79	14.93	14.42	0.51	14.21	13.42	0.79
80^{+}	5.00	5.00	0.00	4.76	4.65	0.11

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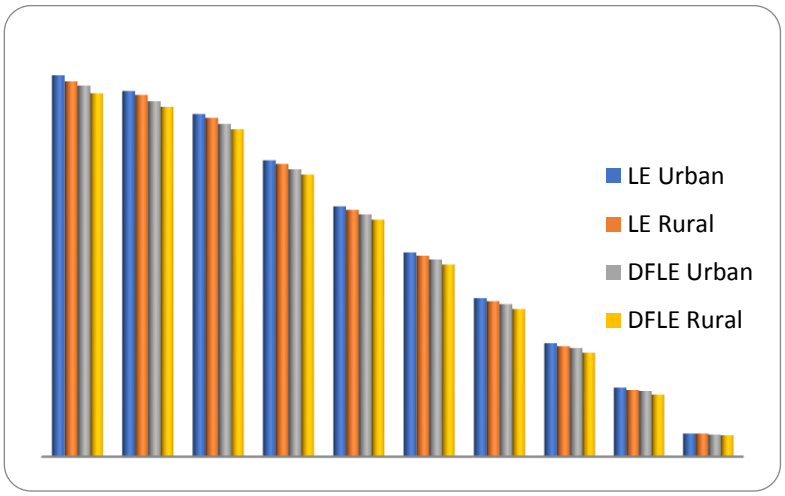

Fig. 1: Urban and Rural Life Expectancies and Urban and Rural DFLE

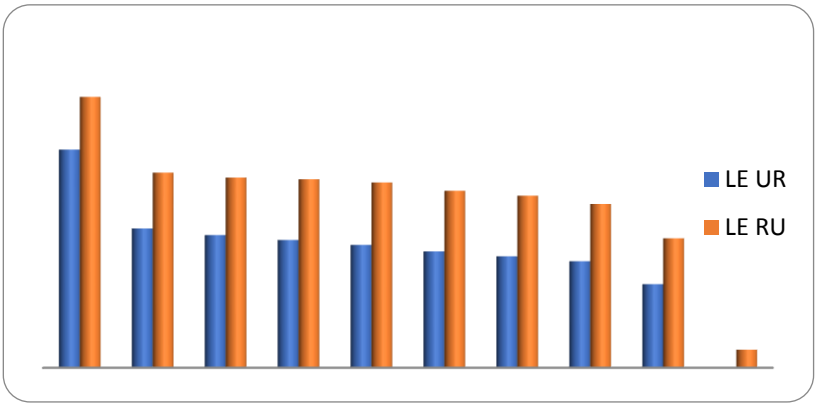

Fig. 2: Difference between Urban and Rural Life Expectancies and Urban and Rural DFLE

VIII. DISCUSSION AND CONCLUSION

Rural areas exhibit higher rates of age-specific mortality than that of its urban counterparts. Higher rates of age-specific disability in rural areas, which is statistically insignificant here, were observed as compared to urban areas. Above two observations reveal about significant differences in disability prevalence and mortality occurrence from birth to age 80^{+}between urban and rural areas of India. Urban population has longer life expectancies and also DFLE than that of rural population from birth to age 80^{+}.

Interdependent relationship between poverty and disability persists as a neglected area of research. The research findings across the world have pointed out that the poorest and most marginalized section in the country is represented by disabled persons and the disability endures an extremely important risk of falling under poverty among the working-age inhabitants. The issue of poverty remains a significant characteristic for persons with disabilities, whereby disability is maintained by both, a cause and consequences of poverty. The present study provides the estimations of DFLE for Urban and Rural areas in India based on Census 2011 data. The findings have essential implications for facilitating to reduce the inequalities in urban and rural health expectation in India. The urban-rural variations like economic development, health care facilities together with their access, educational opportunities and other associated factors are recommended for the lessening to attain the urban-rural inequalities in India.

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